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PRELIMINARY EVALUATION OF A PROTOTYPE AUTOMATED TECHNICAL TRAINING COURSE

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TECHNICAL DOCUMENTARY REPORT NO. MRL-TDR-62-78

July 1962

Behavioral Sciences Laboratory
6570th Aerospace Medical Research Laboratories
Aerospace Medical Division
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio

Project No. 1711, Task No. 171101

[Prepared in part under Contract AF 33(616)-6983]

NOTICES

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25-597, 1200, 4-22-63

FOREWORD

This report was prepared as a joint effort of the Behavioral Sciences Laboratory, 6570th Aerospace Medical Research Laboratories; and the Educational Science Division of U.S. Industries, Inc. working under the terms of Contract No. AF 33(616)-6983. The data on which the report is based were gathered during the period January to June 1961 at Keesler Air Force Base, Mississippi with the participation and support of the 3380th Technical School, Air Training Command. The authors are Dr. Felix F. Kopstein, who also served as Air Force contract technical monitor during this time period, Dr. Virginia Zachert, Project Field Director for Educational Science Division, and Major Richard T. Cave, Operator Training Section, Behavioral Sciences Laboratory, the current contract technical monitor. Mr. James D. Gilmour, Educational Science Division, contributed greatly by providing the Analysis of Variance computation and assisting in the editing and revision of the report.

The work was performed under Task 171101, "Development and Evaluation of a Prototype Automated Technical Training Course" of Project 1711, "Automated Training Materials." This report is in response to Headquarters USAF Operational Support Directive No. 362, dated 11 June 1959, "Automated Training Materials."

Many individuals contributed directly or indirectly to the accomplishment of this study, and their work is gratefully acknowledged. They are listed as follows:

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ABSTRACT

This field study, conducted at Keesler Air Force Base, Mississippi, constituted a preliminary evaluation of intrinsic programming for automated training. Automated instructional materials used during the first 6 weeks of the Communications Electronics Principles course were presented to beginning electronics students via 35-mm film on the AutoTutor Mark I, a rearview projection machine. Using the Keesler Mathematics Test, three groups—Experimental, Control, and Blind Control—were selected and matched from the middle ability range of each of two entering classes. The Experimental group received via the machines all instruction normally received through lecture and discussion. However, they followed the usual method for their practical problems. The students using machines learned adequately from this experimental program. The interpretations of these results and implications for Air Force training are discussed.

PUBLICATION REVIEW

This technical documentary report has been reviewed and is approved.

Walter F. Grether
WALTER F. GRETHER
Technical Director
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TABLE OF CONTENTS

LIST OF TABLES

PRELIMINARY EVALUATION OF A PROTOTYPE AUTOMATED TECHNICAL TRAINING COURSE

INTRODUCTION

The Air Force interest in automated training can be traced back at least to 1951. Beginning then and until the middle 1950's, the Maintenance Laboratory, Air Force Personnel and Training Research Center, Lackland Air Force Base, Texas, devoted considerable resources in developing automated devices and techniques to improve the training of Air Force maintenance personnel. A number of prototype automated trainers, preliminary programs, and proposed experiments were developed by representatives of this organization (refs. 1, 2, 5, 6-10, 14). After this research group was deactivated in 1958, many of these research people continued their work with automated instruction and programmed learning in widely scattered groups.* Because of increasing interest in the possibilities of auto-instructional techniques, a conference, called Automatic Teaching of Verbal and Symbolic Skills, was held at the University of Pennsylvania in 1958, under the sponsorship of the Air Force Office of Scientific Research (ref. 12). At this conference, the discussions by research workers who had been actively experimenting with automated training techniques strongly suggested the feasibility of their application on a large scale. Accordingly, plans for a large-scale field test that had been proposed informally a short time before were reconsidered.

In June 1959, Headquarters USAF issued Operational Support Directive No. 362 for the "Development and Evaluation of a Prototype Automated Technical Training Course" to the Air Force Systems Command (AFSC). It was assigned to the Training Research Branch, Behavioral Sciences Laboratory, 6570th Aerospace Medical Research Laboratories for execution. This directive specified generally the development of automated "...teaching materials with promising potential for reducing instructor requirements and training costs." Supplementary instructions indicated the desire for an objective evaluation of this potential as well as comparisons between the effects of automated and conventional training. Accordingly, plans were prepared to field-test an intrinsically programmed technical training course to assess its ability to develop proficient graduates as compared to that of current conventional instruction in this same course. Additional objectives concerned comparative evaluations of costs, required training time, instructor requirements, interchangability of instruction, device requirements, and so forth.

Initial instructions from Hq USAF provided for the joint conduct of the project by the Air Training Command (ATC) and the Air Force Systems Command. The Air Training Command was assigned the responsibility for providing a test site (school) and vehicle (course), for furnishing students and instructors, and for furnishing general logistic support to personnel collecting evaluation data. The Air Force Systems Command was charged with arranging the preparation of the automated materials, providing all technical monitorship during their development, furnishing the technical direction for the subsequent evaluation, and for drafting of reports.

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*Of the several excellent bibliographies available which list these early Air Force efforts, the reader is referred to: Goebel, L.G., Capt, Air Force Activities in Programmed Learning - A Working Bibliography, Hq Office of Aerospace Research, Washington 25, D.C., February 1962.

The development of the automated course version and the preparation of all requisite materials were delegated to the Educational Science Division (ESD) of U.S. Industries, Inc., under Contract AF 33(616)-6983. Educational Science Division also provided a small field staff at the designated test site to pretest newly prepared automated materials so that any gross shortcomings could be identified and eliminated in revisions. Further, the field staff was to be responsible for suggesting evaluation plans and for collecting the evaluation data.

The choice of a suitable test site and a suitable test vehicle was influenced by the necessity of conducting the entire field test without seriously upsetting established routines in Air Training Command technical schools and without affecting the required rate of production of graduates in a given specialty. These considerations coupled with the need for a constant availability of appreciable numbers of students led to the selection of the Communications Electronics Principles course (ABR 30020) taught at the 3380th Technical School, Keesler Technical Training Center, Keesler Air Force Base, Mississippi. The Communications Electronics Principles (CEP) course is the basic technical course for all of the specialties in Air Force electronics. Hence, it assured a substantial student flow over the period during which the evaluation would be carried out. The other determining factor was the willingness of school authorities to cooperate in the project. The completion of conventional instruction in course ABR 30020 normally requires 19 weeks. Academic instruction is divided into ten instructional blocks totaling 570 hours. The course organization is as follows:

Instructional Blocks	Subjects	Duration in Hours
Block I	Direct Current	60
Block II	Alternating Current	60
Block III	Reactive Circuits	60
Block IV	Principles of Vacuum Tubes and Transistors	60
Block V	Special Purpose Tubes	30
Block VI	Amplifiers and Oscillators	90
Block VII	Special Circuits	90
Block VIII	Motors and Servo Mechanisms	30
Block IX	Multivibrators and Sweep Circuits	60
Block X	Microwave Principles	30

All specialties in the electronic career field complete the first six blocks of instruction. After the sixth block has been completed, certain students destined for one particular specialty leave the course (see figure 1) for specialized training. Other specialties drop out in a similar fashion after the seventh and eighth blocks. The remainder of the students complete all ten blocks of instruction.

The cooperative nature of the project and the geographical dispersion of the major participants required that a formal organization with clearly defined functional responsibilities be set up. Headquarters Air Training Command at Randolph Air Force Base, Texas handled all administrative arrangements for the actual conduct of the field-test. The Behavioral Sciences Laboratory assumed the technical management and direction as well as administration of the contract with the Educational Science Division. Educational Science Division of U.S. Industries, Inc., then at Goleta, California assumed responsibility for the writing, editing, and production of the automated course materials and for the delivery of this material to Keesler Air Force Base. The Project Office at Keesler was jointly staffed by personnel of Air Training Command, Air Force Systems Command, and Educational Science Division.

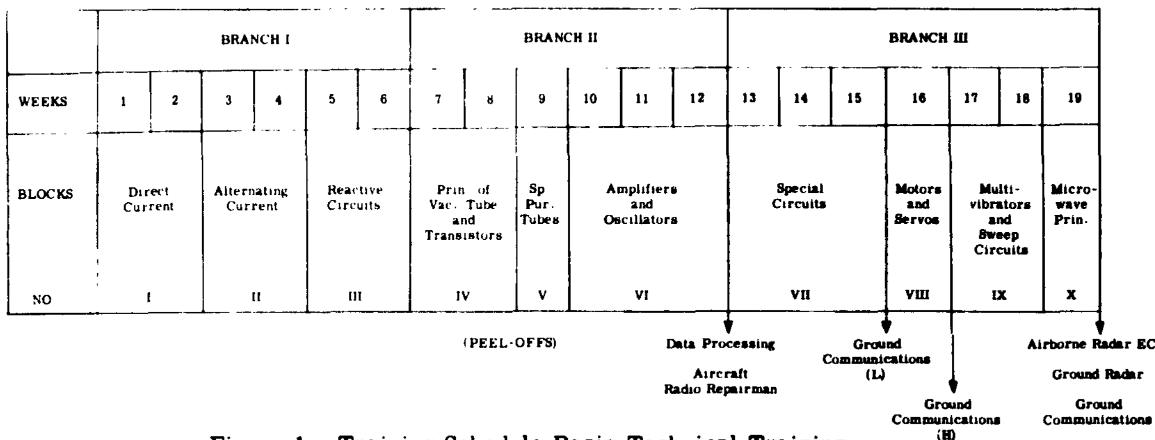

Figure 1. Training Schedule Basic Technical Training (Airman Electronics) ABR 30020

APPROACH AND METHOD OF EVALUATION

Rigney and Fry (ref. 17) have recently surveyed and catalogued existing auto-instructional materials and programming formats. Kopstein and Shillestad (ref. 15) have discussed the varieties of programming formats and their significance in auto-instruction. It will be clear that only one type of programming format could be evaluated in a single field-test unless a truly gigantic effort were to have been initiated. The format chosen for this purpose was Crowder's "intrinsic programming" (ref. 4).

The Intrinsic Programming Technique

Norman A. Crowder, originator of this technique, conceived of it when faced with the problem of training airmen to efficiently diagnose and correct malfunctions in electronic circuitry. This is fundamentally a process of sequential decision-making in which a single, most efficient sequence can be designated. Although any disclosure resulting from a departure from the most efficient sequence does not provide much information in the formal sense and is considered largely redundant, it is also obviously helpful to a student. This observation contains the germ of Crowder's programming format, which is characterized by the two-way responsiveness typically found in the pupil-tutor relationship.

Intrinsic programming is an appropriate title for this technique since the exact program sequence is determined by factors that are intrinsic to the particular student and the particular learning situation. The original strategy or mechanism for intrinsic programming is the scrambled book. On page one of this book (or on the first frame of microfilm, if the material is photographically recorded) the student is introduced to the topic with a short informational paragraph. This is followed by a key question and a choice of several possible answers. Each answer choice is indexed to a page number, or to an image number if microfilm is used. While the sequence of page numbers in the scrambled book is in normal order, there is no topical continuity from page to page. Only when the student turns to the page number corresponding to his answer choice, will he find there a meaningfully related statement. Assuming that his choice is incorrect, he will find on that page (or image) in the following order: (a) a recapitulation of his answer choice, (b) a statement that his answer is incorrect, (c) a brief paragraph reviewing the presumably faulty reasoning that led to this answer choice together with corrective information, and

(d) directions to return to the first page. If it can be assumed that on his second attempt the student makes a correct choice of answers, he will find on the corresponding page the main continuation of the topical material. There will be (a) a recapitulation of the answer choice, (b) a statement that his answer is correct, (c) a review of the reasoning that leads to the correct answer, (d) an extrapolation of this reasoning, which introduces new information, (e) a key question about the new material, and (f) a choice of several possible answers. For more detailed discussions of the intrinsic programming format, see Galanter (ref. 12) and Lumsdaine and Glaser (ref. 16).

When the instructional material is recorded on microfilm, it is projected for actual use on the ground-glass screen of a device known commercially as the Mark I AutoTutor. This device also permits rapid selection of any frame desired for viewing. In this study, the programmed material was recorded on 35-mm microfilm and presented to the students in the Mark I AutoTutor. The material was prepared and filmed in 15 copies and these films were sent to Keesler Air Force Base where they were inserted into the Mark I as needed. One of the advantages of this device is that it produces a permanent tape (made by a printer in the machine) that lists the number of each frame chosen by the student and the amount of time (in tenths of minutes) elapsing between each choice. Thus, a complete record of the presumably significant aspects of each student's learning behavior is recorded and can be subjected to statistical analysis.

Development of the Automated Course

When the Communications Electronics Principles course was originally chosen for the field study, we did not know that it was being revised as of 1 January 1960. This proved to have its advantages and its disadvantages. To obtain the first materials on the course, it was necessary for the Research Engineer to attend classes for the first five blocks to ascertain their precise content, since the printed materials for the course were largely unavailable. As there could be no deviation from the content covered in the course at Keesler, it was necessary to analyze it carefully with respect to detailed topics, terminology, sequence of concepts, relationships among concepts, and so forth, and decide how to best present this instruction information using the intrinsic programming technique.

The initial programming proved to be much more difficult and time consuming than had been anticipated. The Keesler schools do not teach the course content of the first 4 weeks with the same terms and techniques as do most colleges. This proved confusing to the technical writers who constituted the programming staff. They were shortly replaced by professional journalistic writers who knew little or no electronics, but at least did not have to unlearn antagonistic preconceptions.

The evaluation of the programmed material was begun in July 1960 when the first draft of block I course material (on microfilm) was used for training students at Keesler. The data collected for each student from the AutoTutor tapes were tallied daily by individual items. When the students had completed each block, these tallies were forwarded to the editorial staff of Educational Science Division to guide the revision of the material.

During the fall of 1960, the first two blocks of material were revised and new copy was made available for the field study, which began in January 1961. The first draft of block III was added. Unfortunately, problems in the filming of the revised materials resulted in mediocre optical presentation by means of the Mark I AutoTutor.

Routine Teaching of the Communications Electronics Principles Course

All enlisted men entering the 30XXX career field of the Air Force must first pass through the CEP course. Most of the men enter directly from Lackland AFB, Texas, where they have completed part of their basic military training (the last 6 weeks are completed after entering technical school at Keesler). Another large group enters from other career fields or Air Force specialties, often those which have become obsolete. All of these men must have a minimum score of 70 on the Electronic Aptitude Index. Past studies by the Personnel Laboratory at Lackland (before the time when enlistees were tested at recruiting stations) have shown that the Electronic Index has a validity of between .60 and .70 for the various 30XXX schools at Keesler (ref. 3).

Approximately 200 students enter the CEP course each week. These are divided into three shifts: from 0600 to 1200 hours for A-shift; from 1200 to 1800 hours for B-shift; and 1800 to 2400 hours for C-shift. In each of these shifts there are up to five sections of not over 20 students per section. The classes begin on Wednesday of each week. To group the students homogeneously in the various sections of each shift, the CEP administrative personnel developed the Keesler Math Test. This is a 50-item test that was developed to identify students who are extremely weak in math as well as those who are extremely strong. The top 20 percent (as of June 1961) are placed in an accelerated section that covers the first three blocks of material (regularly 6 weeks) in 4 weeks, while the low 20 percent are placed in an improvement section that covers the same amount of material in 8 weeks. The other three sections are scheduled for the regular 6 weeks (figure 2).

REGULAR COURSE

10 Days Direct Current	10 Days Alternating Current	10 Days Reactive Circuits	6 Weeks

IMPROVEMENT TRAINING

15 Days Direct Current	12 Days Alternating Current	13 Days Reactive Circuits	8 Weeks (Bottom 1/5 of Class)
Study Habits Remedial Math.	Reading Improvement Special Assignments		

ACCELERATED PROGRAM

6 Days Direct Current	7-1/2 Days Alternating Current	6-1/2 Days Reactive Circuits	4 Weeks (Top 1/5 of Class)
Less Drill More Rapid Presentation Increased Demonstrations			

Figure 2. Three Speed Levels in Branch I (Blocks I-III)
Branch I - Fundamentals

It is from the three middle sections that the automated training section and its matched control groups were chosen. The A-shift time period was used for the automated study, so that the A-shift study hall from 1730 to 1900 hours might also be used.

In the regular training, each student is issued a student handbook and a student workbook. The handbook is his textbook and the workbook contains problems to be worked out each day. If students fail to keep up with their workbook or make low grades on either daily quizzes or block tests, they are assigned by the instructor to supervised study hall.

In regular training for the first three blocks of material, approximately 20 percent of the teaching time and testing grades are made up of practical work. These are experiments or practical problems that the student performs as outlined in his workbook. Each room is equipped with the necessarv equipment for the experiments constituting part of the work of that week. As the students progress from block to block of instruction, they move from one room to another in order to have the proper equipment. Every room is adequately furnished so that each student does his own work with his own equipment.

At the end of each block, the students are tested by the Instruction and Measurement Branch. The practical tests are given on one day (usually on Fridays) and on Tuesdays all the written tests are given. The written exams are developed in several series and usually consist of 50 items appearing on spearate 5- by 8-inch sheets of paper bound in booklets. Each booklet begins with a different item. The items are reevaluated periodically and new tests are developed from over 10,000 item-card files maintained by this section. The passing score on these tests is set at 78. This figure usually eliminates the bottom 6 to 7 percent. The Evaluation Division of the school does an exceptional job of test development and test examination in keeping the items and tests valid and reliable. Maintaining normal curves by adjusting item difficulty is one of this Division's most important tasks.

In considering a student's grade, it is important to remember that it represents the final school grade and not the individual block grades. If at any time a student is washed-back (fails a block), his grade for that block is the one he receives when he finally graduates from it. In effect, the final course grade is the grade that a student obtains when he has been allowed the necessary number of wash-backs, or additional weeks of training, to finish the course and not the one he would have received from a course of normal length. A normal attrition or wash-back rate in the CEP course is approximately one or two students per section per block. This is especially true for the first five blocks.

The content of the automated training was nearly identical with that of the conventional training. The major difference was that the students used the machines instead of having lectures and demonstrations. An instructor was assigned to the automated class. He was available at all times for individual help and at times, when there were either errors in the TutorFilm or omissions of material, he would discuss this with the entire class. Each day, the homework assignments for the course were made and the workbooks checked. Students getting behind on the AutoTutor, failing to do their homework, or making low grades were assigned to study hall. This was conducted each evening by the project engineer in the machine classroom and not in regular study hall.

Students receiving automated training were selected from the middle achievement group on the Keesler Math Test. They were assigned the regular practical problems, did the regular homework assignments, and were given the regular block examinations. As part of this field study, the experimenters attempted to fit into the regular administrative schedule and frame-work of the school but, at the same time, to secure the advantages of the self-pacing aspects of automated training. The wide range of materials covered in a day or a week by the different students was a major problem. This meant that during the 6 weeks of this study, it was not unusual to have students working on instruction that belonged in at least 3 different weeks and involved different practical problems and required different classrooms having the appropriate equipment. At times, this meant that the regular instructor required two assistants to help the students with their practical work and that additional rooms or equipment had to be obtained for use. It also meant that, on occasion, testing could not be accomplished on the most timely basis.

Evaluation Procedure

To evaluate the automated training materials, machines, and techniques, two pilot studies were completed in the summer and fall of 1960. Gilmore et al. (ref. 13) have reported on some of this work. These studies are summarized but briefly here. The materials were in draft form and a complete item analysis was made of every choice. This was used in rewriting the material, which was made available at the beginning of 1961. The AutoTutor Mark I machines proved themselves rugged and capable instruments. Moreover, the project engineer had learned the machine problems unique to this climate, i.e., salt in the air and its effect on the machines.

The administrative and instructive procedures had been modified to better utilize the automated training potential within the total school organization. It is probable that by January of 1961, when the first study (Study A) began, the automated training section was accepted by the students and school administration as routine and not appreciably different from the kind of deviation introduced by the accelerated classes (top 20 percent) and the improvement classes (lower 20 percent) of the A-shift.

The great interest created by the project generally continued, not only on the Base but in the Air Force. However, the operation had now become a routine matter. During the spring of 1961, there were teams of visiting dignitaries from other branches of the Armed Forces, from other countries, and from the Congress. Numerous training directors of large industries, especially those assigned responsibility for the development of training programs under various government contracts, came to observe automated training and to estimate its potential value. Students were so used to observers that even a USAF General Officer did not cause a stir.

The objective of this study was primarily to obtain a "power" comparison of automated and conventional training. The assumption was made that the CEP Department, because of its extensive background in conducting military electronics training and because of the long experience of each member of its teaching staff, operated at the peak of effectiveness attainable for conventional training. How would automated training compare with respect to its power to produce graduates of acceptable proficiency? Could a highly complex technical course be taught without lectures? A secondary, but possibly even more important, objective was to obtain data concerning the characteristics of automated training per se. Might not its novelty and the publicity surrounding it induce a Hawthorne effect?* Would students tire of too much reading? What administrative problems might be raised by automated training and how could one cope with them? Finally, what further research and evaluation would suggest itself?

To find the answers to these questions, the present field study was begun in January 1961. The automated training material was then available for the first three blocks or 6 weeks of the course. The first class, consisting of 14 students in each of the Control sections and in the Experimental section (Study A) was selected on the basis of scores on the Keesler Math Test and began work on 12 January 1961. To increase the size of the sample, a second class (Study B) was selected immediately after the first class completed the three blocks, and on 1 March 1961 this second class began its training.

Students in the Experimental (automated) group and in the Control group (aware of participation in an experiment) were selected by means of the Keesler Math Test. An equated group was chosen by the same means from the B-shift (1200 to 1800 hours) to serve as a Blind Control group (i.e., unaware of participation in an experiment) which was known only to the project personnel. Since the Keesler Math Test is not extremely sensitive in the mid-range, a more sensitive measure, the Psychological Corporation Electronic and Physical Sciences Aptitude Test (EPSAT), was administered to these and other incoming students for the CEP course. This test, especially the first two sections, has proved to have satisfactory validity for the first three blocks of material and is now being used in other studies.

The selection of incoming students for the present study was restricted to personnel of the Air Force, Air National Guard, and Air Reserve. Allied students were excluded from consideration. Non-commissioned officers were also excluded from the study, except for the Blind Control group.

Information was also obtained on the Aptitude Indices of the students, although in the pilot studies they were not very highly correlated with grades in the first three blocks of the course.

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*This effect was first observed at the Hawthorne plant of the Western Electric Company in a classic study of methods for raising production. Any change of work conditions seemed to increase the productivity of the experimental group of workers. This was interpreted to result from the increased attention and publicity given to these individuals.

A personal data sheet was completed by each student in the Control group and in the Experimental group giving information concerning education to date, home town, courses in math and physics, marital status, age, military rank, and experience.

The experimental group using the AutoTutors automatically produced tapes showing their sequential choice of frames as well as the time, in tenths of minutes, spent on each frame. The tapes were analyzed each day by the project field staff and three or four airmen awaiting school assignment,who were detailed to help tally choices. Each day, students' "error-ratios," or total number of choices over number of incorrect choices, were determined. In the pilot studies, this index had been shown to give a very reliable indication as to whether or not students were successfully mastering the material. The correlations between error-ratio and block grades ranged between .60 and .80. An item analysis of every choice made by each student was prepared and sent to the editors in California to be used in further editing and rewriting the automated training materials. The number of observations obtained on each student thus ran into the hundreds each day. Perhaps this is why the error-ratio score has stood up in all blocks as the one most consistent predictor of course grade.

RESULTS

The first pilot research efforts have been reported elsewhere (ref. 13). These studies, using only blocks I and II, indicated that the basic groups—Experimental, Control, and Blind Control—were logical and feasible groupings for comparison purposes. The Experimental group is consistently a randomly selected set of 14 students whose scores on the Keesler Math Test fall in the middle 60 percent of the distribution. The Control group is a matched set (on the Keesler Math Test) of 14 students, who were aware of their participation in a research project, but who were exposed to the regular course lecture techniques. The Blind Control group was a randomly selected group of 14 from the remaining middle 60 percent of the distribution and were unaware of their participation in the study as their names and scores were known only to the investigators. All airmen who were selected for the Basic Electronics Course had Electronic Aptitude Indexes (Elec AI) above 70. Table I indicates the mean Keesler Math Scores, the mean Elec AI Scores, and the scores on the Engineering and Physical Science Aptitude Test (EPSAT) for the three treatment groups.

TABLE I

A COMPARISON OF THE SELECTION MEAN SCORES FOR THE THREE GROUPS

Group	Keesler Math	Elec AI	EPSAT
Experimental - Study A	60.29	74.64	61.57
Control - Study A	59.00	81.07	60.00
Blind Control - Study A	60.14	81.07	-----*
Experimental - Study B	68.86	80.00	59.43
Control - Study B	67.00	75.00	55.54
Blind Control - Study B	68.86	80.71	57.82

*EPSAT was not administered to this group.

Three treatment groups were selected in January 1961 and completed blocks I, II, and III in their respective mode, hereafter described as study A. The mean scores for these groups on the theory portion of the respective block exams are indicated in table II.

TABLE II

CRITERIA SCORES (THEORY) FOR STUDY A

GROUP	BLOCK I			BLOCK II			BLOCK III		
	MS	n	σ	MS	n	σ	MS	n	σ
Experimental	82.57	14	4.29	82.23	13	6.26	83.64	11	5.77
Control	85.28	14	6.01	82.38	13	6.17	86.80	10	3.36
Blind Control	89.00	14	4.08	83.64	14	6.30	82.92	12	6.75

The differences among means for the three groups within blocks were tested using the t-test and appropriate tables.* Within block I there was a significant mean difference (at the .01 level) between the Experimental group and the Blind Control group. All other mean differences were found to be nonsignificant.

As indicated in table II, one airman from the Experimental group and one from the Control groups washed back after block I. After block II, two more airmen were eliminated from the Experiment group, three more from the Control group, and two from the Blind Control group. This attrition from the beginning samples of 14 in each group meant that only 11 airmen completed all three blocks (the complete study) in the Experimental group, 10 in the Control group, and 12 in the Blind Control group. Further, the reduction in sample occurred solely at the bottom end of the distribution of scores, for only those failing the block were eliminated. For these reasons, the mean scores were recomputed for the three treatment groups using only those subjects who completed all three blocks of instruction or the complete study. These mean scores are indicated in table III.

TABLE III

CRITERIA SCORES (THEORY) FOR STUDY A - REVISED

GROUP	BLOCK I			BLOCK II			BLOCK III		
	MS	n	σ	MS	n	σ	MS	n	σ
Experimental	83.82	11	3.76	83.55	11	5.89	83.64	11	5.77
Control	87.70	10	4.08	85.30	10	2.91	86.80	10	3.36
Blind Control	89.50	12	4.12	85.42	12	4.60	82.92	12	6.75

*See Johnson, P.O., Statistical Methods in Research, pp 71-73, Prentice-Hall, New York, 1949.

Again, the mean differences were examined by means of the t-test. Within block I there was a significant difference (at the .05 level) between the Experimental group and the Control group, and a significant difference (at the .01 level) between the Experimental group and the Blind Control group. All other mean differences were nonsignificant.

Study A was replicated beginning in March 1961 using again three treatment groups of size 14. The mean scores on the theory exams for these groups are indicated in table IV.

TABLE IV

CRITERIA SCORES (THEORY) FOR STUDY B

GROUP	BLOCK I			BLOCK II			BLOCK III		
	MS	n	σ	MS	n	σ	MS	n	σ
Experimental	82.86	14	5.29	80.69	13	5.54	84.67	9	6.44
Control	87.07	14	5.15	85.57	14	3.74	85.57	14	5.45
Blind Control	88.21	14	4.10	86.79	14	5.08	87.21	14	6.41

Again, mean differences were contrasted by using the t-test. A significant difference (at the .05 level) existed between the Experimental group and the Control group within block I. The difference between the Experimental group and the Blind Control group within block I was significant at the .01 level. Within block II, significant differences existed between the Experimental group and the Control group (at the .05 level), and between the Experimental group and the Blind Control group (at the .01 level). Other mean differences were nonsignificant.

The data for study B was recomputed in a similar fashion as for study A to include only those subjects who completed all three blocks of instruction. These results are shown in table V.

TABLE V

CRITERIA SCORES (THEORY) FOR STUDY B - REVISED

GROUP	BLOCK I			BLOCK II			BLOCK III		
	MS	n	σ	MS	n	σ	MS	n	σ
Experimental	85.44	9	3.61	83.44	9	3.84	84.67	9	6.44
Control	87.07	14	5.15	85.57	14	3.74	85.57	14	5.45
Blind Control	88.21	14	4.10	86.79	14	5.08	87.21	14	6.41

All mean differences were compared by using the t-test, and all lacked significance at the .05 level.

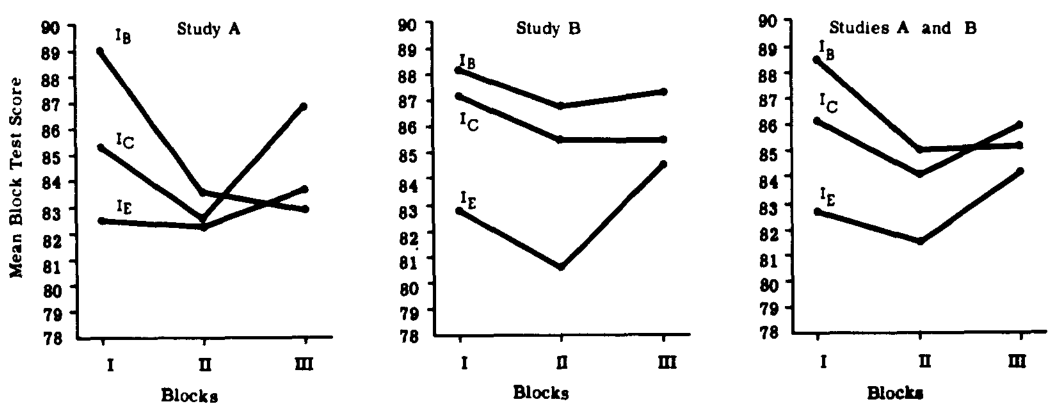
Among the analyses performed principally for the interest of the investigators was a Repeated Observations Analysis of Variance, the results of which appear in table VI. It is included here to demonstrate the high F ratio obtained for within-subject differences between blocks of material and in the second-order interaction. Interactions are also apparent in the graphed means presented in figure 3. Because the samples for the two studies were drawn from two different student groups

(January 1961 and March 1961 entering classes), it is recognized that the data cannot properly be combined for comparison of the treatment groups and that findings must be interpreted as resulting from two separate, but very similar, studies.

TABLE VI

ANALYSIS OF VARIANCE FOR CORRELATED DATA

Source of Variance	df	SS	MS	F	p
Overall Between Subjects	(83)	(7408)			
Treatment Groups	2	861	430.5	5.35	< .01
Studies	1	130	130	1.62	
Groups and Studies	2	143	71.5		
Error (S's w/i Gps and St)	78	6274	80.44		
Overall Within Subjects	(168)	(1809			
Blocks	2	328	164	20.22	< .01
Groups and Blocks	4	64	16	1.97	
Studies and Blocks	2	32	16	1.97	
Groups, Studies, and Blocks	4	120	30	3.70	< .01
Within Subjects Error	156	1265	8.11		
Total	251	9217			



I_E = Experimental "machine" Group

I_C = Control Group

I_B = Blind Control Group

Figure 3. Means for Treatment Groups During Each Block for Studies A, B, and Averaged Over Studies A and B (All Participating Subjects)

A block-by-block, study-by-study Analysis of Variance yielded the F ratios presented in table VII. It should be noted that treatment group N's differ with each analysis, and that in no case do significant F ratios reflect differences between Control and Blind Control treatment groups.

When, as was the case in the earlier discussion of revised criteria scores, individual means are recomputed for each block and each study using only those subjects who completed the three blocks of material (ignoring the effects of selective wash-back at the lower end of the distribution), the resulting means may be plotted as shown in figure 4.

TABLE VII

ANALYSIS OF VARIANCE BY BLOCKS AND STUDIES (F RATIOS)

REPLICATION	BLOCK I	BLOCK II	BLOCK III
A	6.16*	.19	1.43
B	4.69*	5.96**	.54

*p = < .05
**p = < .01

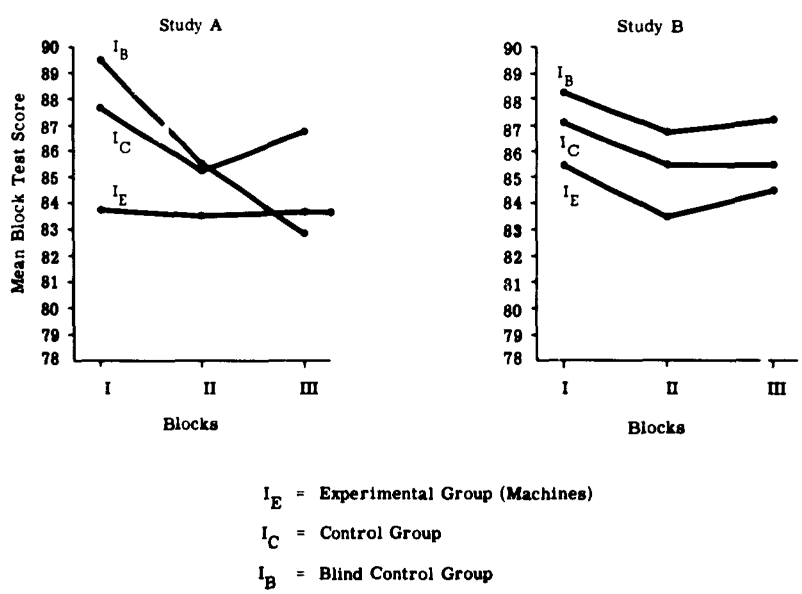


Figure 4. Means for Treatment Groups During Each Block for Studies A and B - Adjusted (Including only those subjects completing material through block III)

Significant differences were found that constantly favored the Control groups. However, the revised data (tables III and V) and the repeated evidence of interaction effects tended to show that these differences either were associated with the introduction of the students to automated instruction or to differences caused by the unequal wash-back of subjects from the three groups. As a result, it is concluded that at least by block III relatively little difference in performance (as indicated on the block exams) existed among the three treatment groups.

The complete raw data is tabled in the appendix. The error ratio scores for the students in the Experimental group continued to correlate significantly with examination grades (+ .68 and + .89) thus upholding the finding of the pilot studies. Cumulative time spent by the student on the AutoTutor, on the other hand, did not show a significant relationship with the criterion scores.

A field study always results in unexpected situations and findings. They are often tragic if one is attempting to have controlled conditions from which statistically meaningful data can be obtained.

The wash-back rate in the first three blocks of the CEP school created a problem in this field study. Should the student be continued on the AutoTutors, or should he be placed in a regular class? It was decided to place him in a regular class with no deficiency against his school record in order that he might have no recourse when, and if, he washed out of the school. This procedure continually reduced the sample size of the Experimental group, and it may also have affected the performance of some Experimental students as this school policy soon became common knowledge among the students.

The lack of a common sample throughout the study caused trouble for the statistician and also for the administrative sergeant who had to program the placement of students. Also, the small sample of only 14 in a class caused much trouble when the flow of students reached almost 100 per week, because the other classes were required to take an overload.

The comments by the men who washed-back on the machines caused the administrative officer to comment that these men complained similarly to those who had failed under his good instructors. He was careful to note the difference between the complaints against good instructors and poor instructors.

Another difficulty in the execution of the field study was that some Experimental subjects were required to wait a day or two between their completion of the instructional block and the administration of the test over that block. The effect of the intervening time may have reduced their test scores, since the auto-instructional devices did not provide an efficient means for reviewing the instructional material.

Certain subjects of the Experimental groups were given 8 hours of instruction on the Auto-Tutors per day instead of the usual 6 hours. This additional 2 hours was substituted for their normal study-hall period. These students had no difficulty maintaining a steady rate of progress over this extended time period. Furthermore, there were no complaints of eye strain even though the visual presentation of the machines was marginal.

Throughout the experimental period, those students whose placement grades were either very high or very low were most complimentary in their reactions to the AutoTutor course. Both the fast and slow students appeared to appreciate moving at their own pace. The better students commented about how nice it was not to have to wait on those slow-pokes and how nice it was not to have to hear everything repeated a dozen times. The slower students thought that it was nice to be able to really understand something before being hurried to the next bit of new material. As a contrast, the average students tended to state that the machines made them work and that they preferred to have someone tell them things, because that system was easier.

The instructor stated that teaching these classes was much more demanding than delivering a prepared lecture, because he had to act as a tutor and be available tohelp each student with his individual problem. Other instructors not directly associated with the AutoTutor classes often commented on the quietness of the experimental classroom.

Students in automated instruction may complete the course of instruction in more or less time than that allotted for conventional instruction. In this study, records were kept of the time to complete each block of instruction. These data will be presented in subsequent reports. Such data are necessary, of course, for a complete evaluation.

CONCLUSIONS AND IMPLICATIONS

Considering all available information, it seems justified to conclude that students trained with the AutoTutors progressed at a rate and to a level nearly comparable with the students instructed in the conventional fashion. Although the examination scores for the Control groups were somewhat higher than comparable scores for the Experimental AutoTutor groups, in a practical sense, the differences were not great. Further, statistically significant differences were primarily confined to scores on examinations given after the first instructional block, and differences tended to be reduced by eliminating scores by subjects who washed-back.

The finding of acceptable progress by students trained on the AutoTutor appears to be pertinent to a relatively wide range of student ability, because the subjects used were representative of the middle 60 percent of incoming course personnel during January and March 1961. There is no reason to believe that personnel entering during these periods were unusual or not representative of students taking the CEP course.

The results reported here are based upon a highly restricted instructional situation. If this kind of machine instruction were to be used within a school such as that at Keesler on a continuing, operational basis, machines would be available 24 hours a day in sufficient numbers to satisfy the needs of the training program. Further, an effort would be made to integrate the automated instruction in the most appropriate manner with the other aspects of the program, such as the practical or laboratory problems and the study halls. That students were washed-back from most groups indicates that there is room for improvement in all the techniques used in either selecting or teaching individuals.

Further research on auto-instructional techniques and materials, on their implications for curriculum planning, and details of school administration is urgently needed. Additional data should be collected using the available machines in combination with modified materials and administrative procedures. A study involving one such modification—programmed material in the form of scrambled books—is in progress and will be reported subsequently, as will studies using students from the top and bottom one-fifth of the distribution on the Keesler Math Test. Improved versions of both the programmed learning material and the presentation device have already been developed by the contractor supplying the materials used in this study. These and other devices now on the commercial market, as well as other programming formats, should be explored for their potential for enhancing the efficiency of auto-instruction beyond that observed here. In short, this study should be interpreted merely as a demonstration of the feasibility of auto-instruction. It does not provide a conclusive estimation of the relative merits of auto-instructional techniques as compared with conventional techniques.

BIBLIOGRAPHY

1. Besnard, G.G., Briggs, L.J., Munsch, G.A., and Walker, E.S., Development of the Subject-matter Trainer, Technical Memorandum No. ASPRL-TM-55-7, Armament Systems Personnel Research Laboratory, Lowry Air Force Base, Colorado, March 1955.

2. Besnard, G.G., Briggs, L.J., and Walker, E.S., The Improved Subject-matter Trainer, Technical Memorandum No. ASPRL-TM-55-11, Armament Systems Personnel Research Laboratory, Lowry Air Force Base, Colorado, April 1955

3. Brokaw, L.D., and Burgess, G.G., Development of Airman Classification Battery AC-2A, Technical Report No. AFPTRC-TR-57-1, Air Force Personnel and Training Center, Lackland Air Force Base, Texas, June 1957.

4. Crowder, N.A., "Automatic Tutoring by Means of Intrinsic Programming," in Galanter, E., (Editor), Automatic Teaching: The State of the Art, John Wiley, New York, New York, 1959.

5. Crowder, N.A., A Part-task Trainer for Troubleshooting, Technical Note No. AFPTRC-TN-57-71, Air Force Personnel and Training Research Center, Lackland Air Force Base, Texas, June 1957.

6. French, R.S., Evaluation of a K-System Trouble-Shooting Trainer, Technical Note No. AFPTRC-TN-56-15, Air Force Personnel and Training Research Center, Lackland Air Force Base, Texas, January 1956.

7. French, R.S., The K-System MAC-1 Trouble-Shooting Trainer: I. Functional Description, Technical Memorandum No. ASPRL-TM-56-8, Armament Systems Personnel Research Laboratory, Lowry Air Force Base, Colorado, April 1956.

8. French, R.S., The K-System MAC-1 Trouble-Shooting Trainer: II. Derivation of Training Characteristics, Technical Memorandum No. ASPRL-TM-56-9, Armament Systems Personnel Research Laboratory, Lowry Air Force Base, Colorado, April 1956.

9. French, R.S., The K-System MAC-1 Trouble-Shooting Trainer: III. Technical Supplement, Technical Memorandum No. ASPRL-TM-56-10, Armament Systems Personnel Research Laboratory, Lowry Air Force Base, Colorado, April 1956.

10. French, R.S., The K-System MAC-1 Trouble-Shooting Trainer: I. Development, Design, and Use, Technical Note No. AFPTRC-TN-56-119, Air Force Personnel and Training Research Center, Lackland Air Force Base, Texas, October 1956.

11. Gagne, R.M., Training Devices and Simulators: Some Research Issues, Technical Report No. AFPTRC-TR-54-16, Air Force Personnel and Training Research Center, Lackland Air Force Base, Texas, May 1954.

12. Galanter, E., (Editor), Automatic Teaching: The State of the Art, John Wiley, New York, New York, 1959.

13. Gilmore, B.H., Crowder, N.A., Benson, E., and Kopstein, F.F., Machine Teaching of Basic Electronics at Keesler AFB: An Experiment, paper given at Department of Audio-visual Instruction of National Educational Association Convention, Miami, Florida, April 1961

14. Hatch, R.S., An Evaluation of the Effectiveness of a Self-Tutoring Approach Applied to Pilot Training, Technical Report No. WADC TR 59-320, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, July 1959.

15. Kopstein, F. F., and Shillestad, Isabel J., A Survey of Auto-Instructional Devices, Technical Report No. ASD TR 61-414, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio, September 1961.

16. Lumsdaine, A. A., and Glaser, R. S., Teaching Machine and Programmed Learning, National Educational Association, Washington, D. C., 1961.

17. Rigney, J. W., and Fry, E. G., A Survey and Analysis of Current Teaching-Machine Programs and Programming, Technical Report No. 31, Electronics Personnel Research Group, Department of Psychology, University of Southern California, February 1961 (ASTIA Document - AD 253 473).

APPENDIX

TABLE VIII

RESEARCH STUDY A - SUMMARY

Group	Subject	Average Grade Blocks I, II & III	Elec AI	EPSAT	Keesler Math Test	Error Ratio	Time (Min.)
EXPERIMENTAL	AEB	92	85	78	60	7.62	3798.6
	AED	88	85	84	66	3.85	3195.5
	AEP	84	70	59	50	2.67	3659.9
	AEH	84	85	73	58	3.55	4077.1
	AEE	84	75	58	56	2.59	3782.0
	AEK	84	75	97	62	3.14	3090.0
	AEC	83	70	48	68	2.70	4176.5
	AEL	81	60	92	58	3.04	2525.8
	AEN	81	75	26	54	1.98	3391.8
	AEF	81	75	48	58	2.43	3782.7
	AEO	80	80	64	52	3.41	4009.6
	AEA	80	70	40	70	3.22	3411.2**
	AEG	79	70	64	64	2.76	1574.6**
	AEM	70	70	31	68	2.43	1182.3*
MEAN		82.21	74.64	61.57	60.29		
CONTROL	ACA	91	95	108	54		
	ACF	90	85	79	58		
	ACD	88	75	54	70		
	ACH	86	75	60	66		
	ACK	85	85	84	52		
	ACL	85	80	49	62		
	ACN	85	75	63	68		
	ACO	85	75	41	58		
	ACM	84	80	58	66		
	ACB	83	75	54	60		
	ACE	83	75	52	56		
	ACG	82	95	52	48		
	ACP	82	85	55	58		
	ACC	70	80	31	50		
MEAN		84.21	81.07	60.00	59.00		
BLIND CONTROL	ABK	91	90		64		
	ABC	89	80		56		
	ABB	88	85		58		
	ABD	88	85		68		
	ABO	88	85		62		
	ABG	87	80		66		
	ABH	86	80		52		
	ABN	85	75		50		
	ABM	84	85		56		
	ABL	83	80		68		
	ABE	82	75		54		
	ABP	81	70		62		
	ABA	72	85		72		
	ABF	72	80		54		
MEAN		84.00	81.07		60.14		

*Block I only on AutoTutor
**Blocks I and II only on AutoTutor

Elec AI - Electronic Aptitude Index
EPSAT - Engineering and Physical Science Aptitude Test

TABLE IX

RESEARCH STUDY A - SUMMARY OF BLOCK GRADES

Group	Subject	Block I Practical	Block I Theory	Block I Final	Block II Practical	Block II Theory	Block II Final	Block III Practical	Block III Theory	Block III Final	Mean
EXPERIMENTAL	AEA	78	78	78	75	75	75*				
	AEB	87	88	88	89	98	96	90	92	91	91.67
	AEC	90	82	84	85	80	81	81	84	83	82.67
	AED	81	92	89	86	87	87	83	90	88	88.00
	AEE	80	83	82	78	83	82	86	85	85	83.00
	AEF	84	80	81	73	80	79	74	77	76*	78.67
	AEG	70	81	79	74	75	75*				
	AEH	86	85	85	80	83	82	80	87	85	84.00
	AEK	79	82	81	81	83	83	88	86	87	83.67
	AEL	88	79	81	90	84	85	90	73	78	81.33
	AEM	72	75	75*							
	AEN	85	81	82	76	78	78	83	85	84	81.33
	AEO	86	85	85	87	76	78	80	77	78	80.33
	AEP	79	85	84	84	87	86	80	84	83	84.33
MEAN		81.79	82.57	82.43	81.38	82.23	82.08	83.18	83.64	83.45	
CONTROL	ACA	90	95	94	89	89	89	90	92	91	91.33
	ACB	86	83	83	82	75	76*				
	ACC	76	70	71*							
	ACD	79	90	88	87	87	87	92	87	89	88.00
	ACE	70	83	80	85	85	85	81	86	85	83.33
	ACF	83	92	90	86	88	88	90	92	91	89.67
	ACG	83	82	82	86	73	77*				
	ACH	91	86	87	80	88	86	80	85	84	85.67
	ACK	88	85	86	89	85	86	83	83	83	85.00
	ACL	85	90	89	86	82	83	82	84	83	85.00
	ACM	86	82	83	87	83	84	85	85	85	84.00
	ACN	79	86	85	89	86	87	83	84	84	85.33
	ACO	83	88	87	81	80	80	81	90	87	84.67
	ACP	84	82	82	84	70	73*				
MEAN		83.07	85.28	84.78	85.46	82.38	83.15	84.70	86.80	86.20	
BLIND CONTROL	ABA	84	84	84	77	70	71*				
	ABB	85	88	87	87	92	91	88	87	87	88.33
	ABC	80	95	92	86	89	88	82	89	87	89.00
	ABD	79	92	89	75	91	88	82	91	88	88.33
	ABE	85	84	84	86	81	82	70	78	76*	80.67
	ABF	88	88	88	80	79	79	80	71	74*	80.33
	ABG	87	88	88	90	87	88	86	83	84	86.67
	ABH	88	92	91	80	86	85	86	80	82	86.00
	ABK	90	95	94	87	87	87	88	94	92	91.00
	ABL	85	88	87	83	76	77*				
	ABM	88	85	86	86	83	84	76	74	75*	81.67
	ABN	88	87	87	81	86	85	84	83	83	85.00
	ABO	86	95	93	80	87	87	88	84	85	88.33
	ABP	84	85	83	86	77	79	80	81	81	81.00
MEAN		85.50	89.00	88.07	83.14	83.64	83.64	82.50	82.92	82.83	

*Wash-back

TABLE X

RESEARCH STUDY A - TABLES OF CORRELATIONS

Variables:

1. Keesler Math Test
2. Average Blocks I, II, and III Final Grades
3. Electronic Aptitude Index
4. Engineering and Physical Science Aptitude Test
5. Time
6. Error Ratio

	1	2	3	4	5	6
1						
2	- .25					
3	- .12	.49*				
4	- .10	.62**	.19			
5	- .06	.05	.47	- .51		
6	.06	.68**	.54*	.45	.10	

Experimental Group (N = 11 to 14)

	1	2	3
1		- .05	.39
2			.25
3			

Blind Control Group (N=14)

	1	2	3	4
1		.39	-.65*	-.07
2			.15	.71**
3				.55*
4				

Control Group (N=14)

*Sign 5%
**Sign 1%

TABLE XI

RESEARCH STUDY B - SUMMARY

	Subject	Average Grade Blocks I, II & III	Elec AI	EPSAT	Keesler Math Test	Error Ratio	Time (Min.)
EXPERIMENTAL	BEE	90	90	97	64	5.20	2703
	BEG	89	85	70	90	3.89	3600
	BEK	87	90	78	68	4.18	2865
	BEM	84	75	32	60	3.02	4061
	BEL	84	85	50	68	2.82	3948
	BEN	82	80	57	78	2.96	3191
	BEF	82	75	56	82	3.46	3074**
	BEA	82	70	48	54	3.26	3909**
	BEO	82	70	72	76	3.33	3432
	BEP	81	85	71	60	2.54	3991
	BED	80	95	82	78	2.59	4469
	BEH	80	75	38	62	1.93	2275**
	BEB	79	75	52	58	2.51	2379**
	BEC	78	70	29	66	2.35	1386*
MEAN		82.86	80.00	59.43	68.86		
CONTROL	BCO	94	75	53	72		
	BCK	89	95	48	74		
	BCE	88	80	51	78		
	BCA	87	80	48	60		
	BCP	87	70	--	56		
	BCB	87	70	--	64		
	BCF	86	70	48	52		
	BCD	86	75	64	58		
	BCG	84	80	70	80		
	BCL	83	70	55	86		
	BCH	83	70	72	68		
	BCN	83	70	61	62		
	BCC	81	75	--	60		
	BCM	81	70	41	68		
MEAN		85.64	75.00	55.54	67.00		
BLIND CONTROL	BBD	94	80	--	90		
	BBH	90	75	61	54		
	BBN	90	95	75	82		
	BBP	89	80	72	66		
	BBG	89	75	68	68		
	BBM	89	80	--	78		
	BBO	88	75	--	78		
	BBA	87	85	48	76		
	BBC	86	80	76	66		
	BBB	86	85	39	64		
	BBL	83	80	37	62		
	BBF	81	80	57	58		
	BBK	81	80	41	62		
	BBE	80	80	62	60		
MEAN		86.64	80.71	57.82	68.86		

*Block I only on AutoTutor
**Blocks I and II only on AutoTutor

Elec AI - Electronic Aptitude Index
EPSAT - Engineering and Physical Science Aptitude Test

TABLE XII

RESEARCH STUDY B - SUMMARY OF BLOCK GRADES

	Subject	Block I			Block II			Block III			Mean
		Practical	Theory	Final	Practical	Theory	Final	Practical	Theory	Final	
EXPERIMENTAL	BEA	76	79	78	82	78	79**				
	BEB	80	79	79	79	71	73*				
	BEC	70	70	70*							
	BED	82	82	82	81	80	80	80	74	76*	79.33
	BEE	92	90	90	82	89	88	92	94	93	90.33
	BEF	70	82	80	79	76	77*				
	BEG	92	90	90	89	88	88	84	90	88	88.67
	BEH	85	81	82	82	73	75*				
	BEK	89	85	86	81	88	87	88	89	89	87.33
	BEL	87	83	84	86	81	82	83	86	85	83.67
	BEM	79	88	86	76	83	82	86	85	85	84.33
	BEN	82	82	82	79	82	81	77	87	84	82.33
	BEO	80	88	86	78	81	80	80	79	79	81.67
	BEP	89	81	83	85	79	80	80	78	79	80.67
MEAN		82.36	82.86	82.71	81.46	80.69	80.92	83.33	84.67	84.22	
CONTROL	BCA	94	88	89	89	85	86	92	85	87	87.33
	BCB	92	86	87	84	89	88	88	83	85	86.67
	BCC	76	82	81	72	83	81	86	80	82	81.33
	BCD	82	88	87	82	89	88	77	84	82	85.67
	BCE	92	95	94	84	86	86	81	86	85	88.33
	BCF	82	95	92	80	85	84	84	83	83	86.33
	BCG	79	85	84	79	83	82	80	89	86	84.00
	BCH	84	78	79	83	84	84	92	82	85	82.67
	BCK	87	88	88	89	88	88	84	96	92	89.33
	BCL	83	86	85	81	80	80	84	85	85	83.33
	BCM	82	81	81	82	83	83	82	79	80	81.33
	BCN	81	86	85	85	81	82	84	80	81	82.67
	BCO	94	95	95	90	94	93	92	96	95	94.33
	BCP	79	86	85	83	88	87	88	90	89	87.00
MEAN		84.79	87.07	86.57	83.07	85.57	85.14	85.29	85.57	85.50	
BLIND CONTROL	BBA	80	88	86	82	86	85	86	91	90	87.00
	BBB	81	91	89	85	85	85	86	83	84	86.00
	BBC	85	86	86	83	89	88	80	87	85	86.33
	BBD	92	93	93	90	95	94	92	96	95	94.00
	BBE	77	82	81	79	79	79	84	79	81	80.33
	BBF	70	85	82	79	81	81	84	78	80	81.00
	BBG	80	91	89	86	87	87	84	93	90	88.67
	BBH	83	93	91	82	94	92	82	89	87	90.00
	BBK	78	83	82	80	79	79	81	75	77*	79.33
	BBL	85	81	82	82	84	84	81	84	83	83.00
	BBM	81	89	87	89	91	91	80	91	88	88.67
	BBN	77	91	88	90	92	92	85	91	89	89.67
	BBO	79	91	89	83	86	85	90	91	91	88.33
	BBP	87	91	90	79	87	85	88	93	92	89.00
MEAN		81.07	88.21	86.79	83.50	86.79	86.21	84.50	87.21	86.57	

*Wash-back
**Emergency Leave

TABLE XIII

RESEARCH STUDY B - TABLES OF CORRELATIONS

Variables:

1. Keesler Math Test
2. Average Blocks I, II, and III Final Grades
3. Electronic Aptitude Index
4. Engineering and Physical Science Aptitude Test
5. Time
6. Error Ratio

	1	2	3	4	5	6
1						
2	.28					
3	.29	.53*				
4	.33	.57*	.73**			
5	.01	-.52*	.01	-.44		
6	.23	.89**	.38	.67**	-.82**	

Experimental Group (N = 14)

	1	2	3	4
1		.70**	.34	.28
2			.00	.58*
3				.07
4				

Blind Control Group (N = 11 to 14)

	1	2	3	4
1		.10	.32	.12
2			.41	-.20
3				-.17
4				

Control Group (N = 11 to 14)

*Sign 5%
**Sign 1%

Aerospace Medical Division, 6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio
Rpt. No. MRL-TDR-62-78. PRELIMINARY EVALUATION OF A PROTOTYPE AUTOMATED TECHNICAL TRAINING COURSE. Final report, July 1962, iv + 22 pp, incl. illus. tables, 17 refs. Unclassified report

This field study, conducted at Keesler Air Force Base, Mississippi, constituted a preliminary evaluation of intrinsic programming for automated training. Automated instructional materials used during the first 6 weeks of the Communications Electronics Principles course were presented to beginning electronics students via 35-mm film on the AutoTutor Mark I, a rearview projection (over)

machine. Using the Keesler Mathematics Test, three groups — Experimental, Control, and Blind Control — were selected and matched from the middle ability range of each of two entering classes. The Experimental group received via the machines all instruction normally received through lecture and discussion. However, they followed the usual method for their practical problems. The students using machines learned adequately from this experimental program. The interpretations of these results and implications for Air Force training are discussed.

UNCLASSIFIED

1. Training devices
2. Programming
3. Autoinstructional devices
4. Autotutor Mark I

I. AFSC Project 1711, Task No. 171101
II. Behavioral Sciences Laboratory
III. F. F. Kopstein, R. T. Cave
IV. Contract AF 33(616)-6983
V. U.S. Industries, Inc New York, N. Y.

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VI. In ASTIA collection
VII. Aval fr OTS: $0.75

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